LOCOMOTION IN YOUNG COLONIES OF PECTINATELLA MAGNIFICA.

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Pectinatella magnifica is the largest of the fresh-water bryozoa (Phylactolæmata). It is a distinctively American form and is generally known by the conspicuously large masses of it, which are formed in the late summer and fall. These masses commonly are as large as a man's head and often attain the size of sixteen by eight or nine inches. They are found floating or attached to submerged solid material in some of our purest fresh-water ponds and reservoirs. Each of these masses consists of a thin coating of *Pectinatella* colonies attached to a thick substratum of transparent, colorless jelly. The colonies are diamond-shaped in general form, with many slender, radiating lobes, each bordered by a double row of actively-contracting polypides.

These jelly masses are one of the most unique phases of the life-history of the species. In order to understand their mode of formation, I undertook a preliminary study of the growth and behavior of the young *Pectinatella* colonies. This resulted in the discovery that during their early stages these colonies have the power of independent motion. This paper gives the evidence of this fact of *locomotion in young Pectinatella colonies.*

It was long believed that the power of locomotion in the bryozoa was confined to the genus *Cristatella*, of which it is a striking characteristic. But a Danish zoölogist, Wesenburg-Lund ('96), discovered that another genus of the Phylactolæmata, *Lophopus*, has this power of independent locomotion. He observed that the young *Lophopus* colonies sometimes migrate six centimeters in the course of twelve hours.

In 1901 I studied young colonies of *Pectinatella magnifica* under most favorable conditions at Cold Spring Harbor, L. I. There *Pectinatella* occurs in abundance in three connecting fresh-water ponds. Flood-gates separate the adjacent ponds and to these the statoblasts of *Pectinatella* often attach themselves and

give rise to young colonies. The colonies on one gate I observed regularly at twenty-four hour intervals for a period of six weeks from June 8 to July 21. The observations were recorded in a series of forty-three outline drawings made to scale, showing the colonies in their actual position in relation to certain fixed lines. A selected series of fifteen of these figures is reproduced to illustrate this paper.

In each figure, the unbroken outlines represent the position of the colonies on the date indicated, and the broken outlines their position the previous day. The two straight lines, crossing each other at right angles represent the fixed reference lines on the flood-gate.

Fig. 1 represents two small colonies, *A* and *B*. Colony *A* has just come out of its statoblast and become attached. Colony *B* is somewhat older and about three times as large as *A*.

Fig. 2 represents the same colonies two days later. Their size is not perceptibly increased, but both colonies have moved to the right and *A* has approached a little nearer to *B*. *B* shows a slight constriction preliminary to division.

Fig. 3 represents colonies, *A* and *B*, after another interval of three days. Both colonies have increased in size and are coming still nearer together. *B* is becoming definitely lobed.

Fig. 4 represents the conditions one day later. Colony *A* has migrated back toward its original position. Colony *B* has divided by fission into two parts, B^1 and B^2.

Fig. 5 represents the colonies the following day. Colony *A* is still shifting its position slightly, but without increasing in size. Colonies, B^1 and B^2, are already beginning to move apart and to change their position in relation to colony *A*.

Fig. 6 represents the conditions seven days later. After a period of comparative rest colony *A* has moved to a new position and increased in size. Colonies, B^1 and B^2, are still changing their absolute and relative positions.

Fig. 7 represents the colonies three days later. Each has definitely enlarged and changed its position somewhat. B^2 has moved entirely off its position of the day before as shown by comparing the even and broken outlines of the colony.

Fig. 8 represents the conditions after another interval of three

days. It shows further increase in size and a greater degree of locomotion of each of the colonies.

Fig. 9 represents the colonies three days after Fig. 8. Marked changes have occurred; colony A has more than doubled its size and has divided into two parts: A^1 and A^2, each of which is moving; A^1 is growing and migrating; B^2 has just divided into two parts: $B^{2.1}$ and $B^{2.2}$.

Fig. 10 represents the colonies two days after Fig. 9. They are in a state of rapid growth as indicated by their increased size and their definitely-lobed margins.

Fig. 11 represents the colonies two days later, indicating important changes. Colony A^1 is divided into two: $A^{1.1}$ and $A^{1.2}$, which are moving apart. Colony A^2 is much enlarged and divided into $A^{2.1}$ and $A^{2.2}$. Colony B^1 has become deeply lobed. Colony $B^{2.1}$ is moving and preparing to divide. Colony $B^{2.2}$ has divided into colonies $B^{2.2.1}$ and $B^{2.2.2}$.

Fig. 12 represents the conditions three days later. It shows increase in size of each of the colonies, and further division of colonies $A^{2.1}$, $A^{2.2}$, B^1 and $B^{2.1}$. Also a part of colony $B^{2.2}$ has fused with a part of colony $A^{2.2}$. From this time forward the locomotion of the individual colonies cannot keep pace with their growth. Hence as the colonies divide and move apart they come in contact with other colonies with which they fuse.

Fig. 13 represents the colonies two days after Fig. 12. A number of the colonies are literally running together.

Fig. 14 represents the conditions after an interval of three days. It shows marked growth in every direction. All but a few outlying colonies are united in a single mass.

Fig. 15 represents the colonies three days later. They are forming one continuous mass, which is not only expanding its area rapidly, but also is thickening perceptibly, especially in the middle. The latter change is due to the heaping up of the secretion of the under surface of the colonies.

This study of the young *Pectinatella* colonies shows very conclusively that they possess the power of *locomotion.* This power is definitely associated with the phenomena of growth and division. The increasing size of a colony causes it to divide. The fact that young *Pectinatella* colonies multiply by fission was first

brought out by Hyatt (65). The frequent division of the colonies along with the tendency toward further growth occasions locomotion.

The real cause of locomotion must however be referred back to the activity of the moving colonies and the condition of the substratum on which they rest. The individual polypides of *Pectinatella* are very irritable. They contract and expand frequently and with some force. All the polypides on one side of a colony contracting simultaneously give impetus enough to move the whole colony over a slippery surface. The gelatinous secretion which underlies the young colonies has not yet hardened, and in its semi-fluid state offers a slimy surface over which the small colonies move with very little resistance.

The rate and amount of locomotion varies with the size and condition of the colony. After a colony is well started and growing rapidly, it divides often and the resulting colonies move apart quickly and as far as the free space about them permits. But there are limits to this power of locomotion. The colonies can move only as they are impelled by the activity of the polypides. Hence as the polypides lose their vigor, as they do during reproduction, locomotion must cease. The power of locomotion also decreases with the increasing size of the colonies. The external conditions also limit locomotion. So long as the gelatinous substratum is in a semi-liquid state, the young colonies move with freedom, but as it gradually solidifies they become fixed. Often locomotion is limited also by the space about the colony. If two colonies in process of locomotion come in contact with each other, their motion is checked and they fuse together. As the colonies spread and form a confluent mass, further growth is allowed for only by the rapid thickening of the gelatinous ectocyst.

But what is gained by this unique power of locomotion? As division is necessary to keep the individual colonies small, so locomotion after division, is necessary to allow growth to proceed freely in all directions, and the characteristic radiately-lobed colonies to be formed.

This discovery of locomotion is significant, owing to the light which it throws upon the mode of development of the large

fall masses of *Pectinatella magnifica* already referred to. The only theory of their origin, on record up to this time, is that of Hyatt ('65), who believed that each mass was derived from as many statoblasts as there are colonies. In the light of this study, it is evident that each mass arises from relatively few, instead of innumerable statoblasts, and that it is formed in a similar way to the mass resulting from the two colonies, *A* and *B*, that is, through the combined phenomena of growth, division and locomotion.

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ANATOMICAL LABORATORY, June, 1906.

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Description of Plates.

Plate VIII.

Fig. 1 represents *Pectinatella magnifica*, colonies: A, B. July 8.
Fig. 2 represents *Pectinatella magnifica*, colonies: A, B. July 10.
Fig. 3 represents *Pectinatella magnifica*, colonies: A, B. July 13.
Fig. 4 represents *Pectinatella magnifica*, colonies: A, B^1, B^2. July 14.
Fig. 5 represents *Pectinatella magnifica*, colonies: A, B^1, B^2. July 15.
Fig. 6 represents *Pectinatella magnifica*, colonies: A, B^1, B^2. July 22.
Fig. 7 represents *Pectinatella magnifica*, colonies: A, B^1, B^2. July 25.
Fig. 8 represents *Pectinatella magnifica*, colonies: A, B^1, B^2. July 28.
Fig. 9 represents *Pectinatella magnifica*, colonies: A^1, A^2, B^1, $B^{2 \cdot 1}$, $B^{2 \cdot 2}$. August 1.

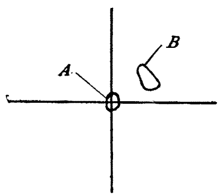


FIG. 1.

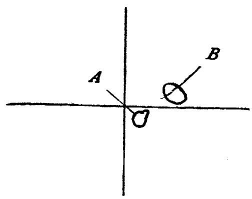


FIG. 2.

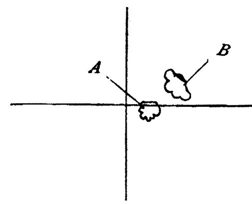


FIG. 3.

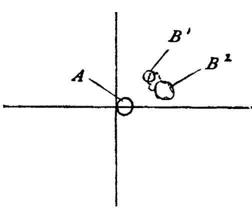
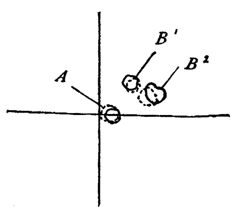


FIG. 4.



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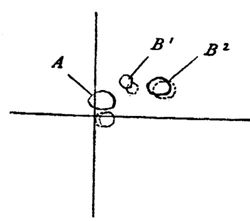

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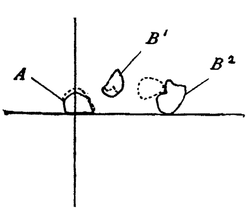

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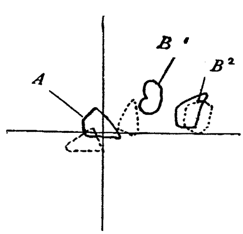

FIG. 8.

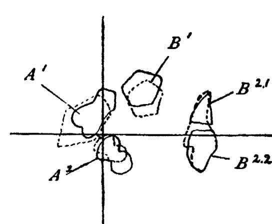

FIG. 9.

PLATE IX.

Fig. 10 represents *Pectinatella magnifica*, colonies: A^{1}, A^{2}, B^{1}, $B^{2 \cdot 1}$, $B^{2 \cdot 2}$, August 3.

Fig. 11 represents *Pectinatella magnifica*, colonies: $A^{1 \cdot 1}$, $A^{1 \cdot 2}$, $A^{2 \cdot 1}$, $A^{2 \cdot 2}$, B^{1}, $B^{2 \cdot 1}$, $B^{2 \cdot 2 \cdot 1}$, $B^{2 \cdot 2 \cdot 2}$. August 5.

Fig. 12 represents *Pectinatella magnifica*, colonies: $A^{1 \cdot 1}$, $A^{1 \cdot 2}$, $A^{2 \cdot 1 \cdot 1}$, $A^{2 \cdot 1 \cdot 2}$, $A^{2 \cdot 2 \cdot 1 \cdot 1}$, $A^{2 \cdot 2 \cdot 1 \cdot 2}$, $A^{2 \cdot 2 \cdot 2}$, $B^{1 \cdot 1}$, $B^{1 \cdot 2 \cdot 1}$, $B^{1 \cdot 2 \cdot 2}$, $B^{2 \cdot 1 \cdot 1}$, $B^{2 \cdot 1 \cdot 2}$, $B^{2 \cdot 2 \cdot 1}$, $B^{2 \cdot 2 \cdot 2}$. August 8.

Fig. 13 represents the same colonies as Fig. 12 fusing. August 10.

Fig. 14 represents the same colonies as Fig. 12 fusing. August 13.

Fig. 15 represents the same colonies as Fig. 12 fusing. August 16.

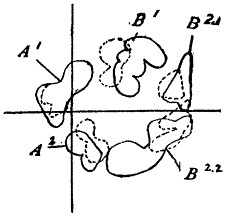

FIG. 10.

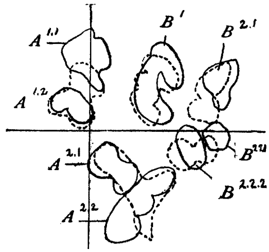

FIG. 11.

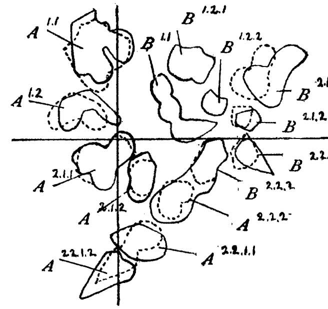

FIG. 12.

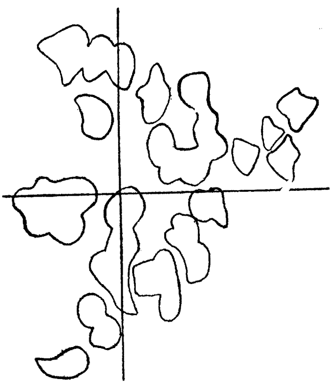

FIG. 13.

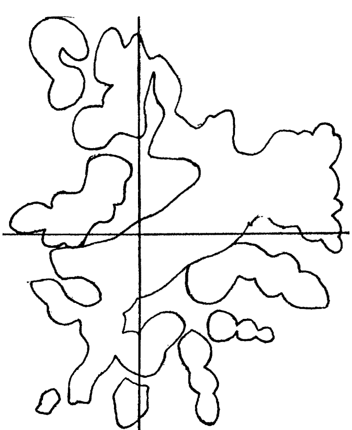

FIG. 14.

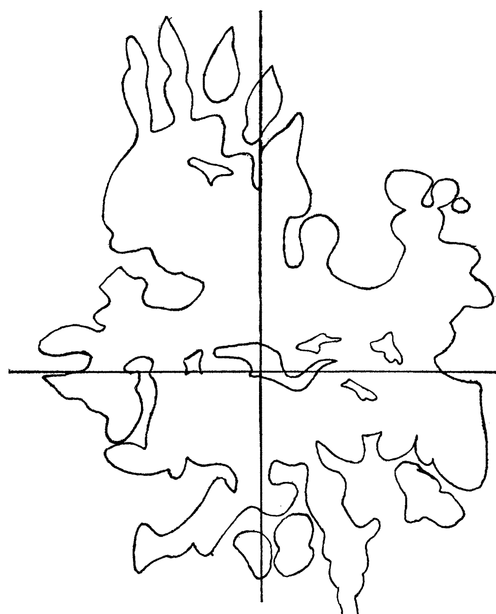

FIG. 15.